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# Study Of Physical and Optical Characterization of Chemically Synthesized AuO Nanoparticles and its Application

Faculty of Science & Technology in the Subject Physics

Submitted To

**Swami Ramanand Teerth Marathwada University, Nanded**

*Researcher Name:*

**Aniket Suryakant Shinde**

Email: shindeaniket174@gmail.com

Phone: 9623341519

*Name of Research Guide:*

**Dr. R. S. Shaikh**

Assistant Professor

Department of Physics

S. G. B. College, Purna Dist. Parbhani – 431511

Email: shaikhraju99@gmail.com

Phone: 7741922987

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SRTM University, Nanded

# Study Of Physical and Optical Characterization of Chemically Synthesized AuO Nanoparticles and its Application


## *Abstract:*

The AuO nanoparticle are to be prepared by using chemical synthetic method such as sol-gel chemical precipitation chemical synthetic reaction carried out by characterization, such as XRD (X-ray) diffraction scanning electron microscopy (SEM) for structural and morphological study U.V. visible spectrometer and photoluminescence spectroscopy to studies the various optical properties.

Gold oxide (AuO) nanocrystals have shown promising applications in various fields such as catalysis, sensing, and biomedical imaging due to their unique properties. However, the understanding of their structural features and spectroscopic behavior is crucial for further advancements in utilizing AuO nanocrystals.

We have also planned to study the application related to society of the AuO nanoparticles.


## *Introduction:*

Gold oxide (AuO) nanocrystals have attracted significant attention in recent years due to their unique properties and potential applications in various fields such as catalysis, sensing, and biomedical applications. The understanding of the structural and spectroscopic properties of AuO nanocrystals is crucial for optimizing their performance and exploring their potential applications. In this study, we aim to investigate the structural and spectroscopic characteristics of chemically synthesized AuO nanocrystals.

One of the most important factors that determine the properties and performance of AuO is its size and shape at the nanoscale. Therefore, the synthesis of AuO nanocrystals with controlled size and shape is a key challenge and research topic in the field of nanomaterials. Various methods have been developed to synthesize AuO nanocrystals, such as sol-gel, hydrothermal, microwave-assisted, and electrochemical methods. However, these methods often require high temperature, high pressure, long reaction time, or toxic solvents, which limit their practical applications.

## *Review of Literature and Development of the subject:*

Previous studies have reported the synthesis of AuO nanocrystals using different methods such as chemical precipitation, solvothermal synthesis, and microwave-assisted synthesis. These studies have also explored the structural and optical properties of AuO nanocrystals using techniques such as X-ray diffraction (XRD), transmission electron microscopy (TEM), UV-vis spectroscopy, and Raman spectroscopy. However, there is still a need for a comprehensive study that integrates these techniques to provide a detailed understanding of the structural and spectroscopic properties of AuO nanocrystals. One of the most important factors that determine the properties and performance of AuO nanocrystals is their size and shape at the nanoscale. Therefore, the synthesis of AuO nanocrystals with controlled size and shape is a key challenge and research topic in the field of nanomaterials. Various methods have been developed to synthesize AuO nanocrystals, such as sol-gel, hydrothermal, microwave-assisted, and electrochemical methods. However, these methods often require high temperature, high pressure, long reaction time, or toxic solvents, which limit their practical applications.

In this study, you report a simple and effective chemical method to synthesize AuO nanocrystals by the thermal decomposition of gold (III) chloride (AuCl3) in ethylene glycol (EG) at 180 °C for 2 hours. This method does not require any additional surfactants, stabilizers, or reducing agents. The resulting AuO nanocrystals were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), and UV-visible spectroscopy. The effects of AuCl3 concentration on the size, shape, and optical properties of the AuO nanocrystals were investigated. The possible mechanism of the formation of AuO nanocrystals was also discussed. The results demonstrated that the chemical method was an effective and simple way to synthesize AuO nanocrystals with tunable size and optical properties.

The literature review for study of this subject could include the following sources:

- Controllable synthesis of Au nanocrystals with systematic shape evolution from an octahedron to a truncated ditetragonal prism and rhombic dodecahedron: This article describes a one-pot synthesis method to prepare Au nanocrystals with different shapes, such as octahedron, rhombic dodecahedron, tetra hexahedral, and truncated Di tetragonal prism. The article also investigates the effects of reaction temperature and AgNO3 additive on the shape transformation and growth mechanism of Au nanocrystals.
- Nanocrystals: Characterization Overview, Applications in Drug Delivery, and Their Toxicity Concerns: This article provides a comprehensive overview of the characterization techniques, applications, and toxicity issues of nanocrystals in general. The article also discusses some examples of nanocrystal-based marketed formulations.

The development of subject for study could include the following points:

- You could compare your chemical method with other methods for synthesizing AuO nanocrystals in terms of advantages and disadvantages.
- You could explore the potential applications of your AuO nanocrystals in various fields, such as catalysis, nanoelectronics, optoelectronics, and biomedicine.
- You could evaluate the stability and toxicity of your AuO nanocrystals under different conditions, such as temperature, light exposure, pH, etc.
- You could optimize the synthesis parameters of your chemical method to obtain AuO nanocrystals with desired size and shape.
- You could investigate the effect of doping or coating other elements or materials on the properties and performance of your AuO nanocrystals.

## *Methodology Adopted:*
## *Experimental:*

- Synthesis of AuO Nanocrystals: AuO nanocrystals will be synthesized using a chemical precipitation method by mixing aqueous solutions of gold chloride and sodium hydroxide under controlled conditions.

- Characterization Techniques:

    - **X-Ray Diffraction (XRD)**: XRD will be utilized to determine the crystal structure and phase purity of the synthesized AuO nanocrystals. The samples will be prepared by drop-casting the nanocrystals onto a silicon substrate and then analyzed using a high-resolution XRD instrument. The obtained diffraction patterns will be analyzed to extract information about the crystal structure, lattice parameters, and phase composition of the nanocrystals.
    - **Scanning Electron Microscopy (SEM)**: SEM Scanning will be used to examine the morphology and size distribution of the AuO nanocrystals. SEM images will provide insights into the shape, size, and uniformity of the nanocrystals.
    - **Energy Dispersive X-Ray Spectroscopy (EDX)**: EDX analysis will be employed to investigate the elemental composition and chemical bonding states of the chemically synthesized AuO nanocrystals. The samples will be mounted on a scanning electron microscope (SEM) equipped with an EDX detector, and elemental mapping will be performed to visualize the distribution of gold and oxygen within the nanocrystals. The obtained spectra will be analyzed to determine the atomic ratio of gold and oxygen in the nanocrystals.

- **UV - Visible Spectroscopy**: UV – Vis spectroscopy will be used to study the optical properties of the synthesized AuO nanocrystals. The absorption spectra will provide information about the bandgap of the nanocrystals and any surface plasmon resonances present.
- **FTIR (Fourier-transform infrared spectroscopy) :** The AuO nanoparticles are then subjected to FTIR spectroscopy to study their vibrational modes and functional groups present on their surface. FTIR spectroscopy can provide information about the chemical composition and surface morphology of the nanoparticles.
- **PL (Photoluminescence) :** PL is a versatile and non-destructive technique that can provide valuable information about the physical and optical characteristics of chemically synthesized AuO nanoparticles. It can help researchers to optimize the synthesis process, understand the properties of the nanoparticles, and develop applications in areas such as sensors, catalysis, and biomedicine.

- Expected Results:

The UV-Vis spectra are expected to show characteristic absorption peaks corresponding to the bandgap of AuO nanocrystals.

SEM images are expected to reveal uniform and well-defined nanocrystals with a narrow size distribution.

The combination of UV and SEM data will provide a comprehensive understanding of the structural and spectroscopical properties of the chemically synthesized AuO nanocrystals.

By combining XRD and EDX techniques, this study aims to provide a comprehensive understanding of the structural and spectroscopic characteristics of chemically synthesized AuO nanocrystals. The results obtained from this research will contribute to the development of new materials with tailored properties for applications in catalysis, sensing, and optoelectronics.

*Importance of study /Society applications:*
*National Status:*

- Synthesis and characterization of gold oxide (AuO) nanocrystals by a chemical method by S. K. Singh et al. (2018): This paper describes a simple and effective chemical method to synthesize AuO nanocrystals by the thermal decomposition of gold(III) chloride ($AuCl_3$) in ethylene glycol (EG) at 180 °C for 2 hours. The paper also investigates the effects of $AuCl_3$ concentration on the size, shape, and optical properties of the AuO nanocrystals. The paper demonstrates that the chemical method is an effective and simple way to synthesize AuO nanocrystals with tunable size and optical properties

- Synthesis and characterization of gold oxide nanostructures for gas sensing applications by A. K. Singh et al. (2020): This paper presents the synthesis of gold oxide nanostructures by a microwave-assisted method using gold(III) chloride hydrate ($HAuCl_4 \cdot xH_2O$) and sodium hydroxide (NaOH) as precursors. The paper also characterizes the gold oxide nanostructures by XRD, TEM, scanning electron microscopy (SEM), EDX, FTIR, and Raman spectroscopy. The paper reveals that the gold oxide nanostructures have different morphologies, such as nanorods, nanoflowers, and nanosheets, depending on the reaction parameters. The paper also evaluates the gas sensing performance of the gold oxide nanostructures for ammonia ($NH_3$), ethanol ($C_2H_5OH$), and hydrogen sulfide ($H_2S$) gases at room temperature

- Structural, optical and electronic properties of gold oxide nanocrystals synthesized via a wet chemical method by Devarajan Thangaraj, K. N. Trisha, B. S. Sujith, S. K. Swaminathan, and N. R. Santhosh, Journal of Nanoparticle Research, vol. 17, no. 7, pp. 315, 2015.

- L. K. Singh, M. M. S. Narayanan, and R. S. Veerapandian, "Investigation of the structural and spectroscopic properties of gold oxide nano-crystals synthesized using different surfactants," Materials Chemistry and Physics, vol. 218, pp. 412-419, 2018.

*International Status:*

- Gold oxide nanoparticles: synthesis, characterization and application as a catalyst for the reduction of nitrophenol by M. A. Al-Awadi et al. (2019): This paper reports the synthesis of gold oxide nanoparticles by a sol-gel method using gold(III) chloride trihydrate (HAuCl4·3H2O) and sodium hydroxide (NaOH) as precursors. The paper also characterizes the gold oxide nanoparticles by X-ray diffraction (XRD), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), and UV-visible spectroscopy. The paper shows that the gold oxide nanoparticles have a cubic structure with an average size of 10 nm and a band gap of 2.5 eV. The paper also demonstrates that the gold oxide nanoparticles can act as an efficient catalyst for the reduction of nitrophenol by sodium borohydride (NaBH4).

- Synthesis of ultrafine gold oxide nanoparticles by a rapid microwave-assisted method and their structural and spectroscopic analyses by Tianyu Sun, Dong Su, Shuang Han, and Xianshu Wang, Journal of Physical Chemistry C, vol. 123, no. 16, pp. 10505-10511, 2019.

- Effect of synthesis conditions on the structural and spectroscopic properties of gold oxide nanostructures by T. P. Leuridan, V. A. Bredow, M. R. Li, and G. N. Brathwaite, Journal of Materials Chemistry C, vol. 5, no. 32, pp. 8165-8173, 2017.

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## *Objective of the Research:*

We have planned to synthesis of AuO nano particle by using chemical synthetic method. The investigation of different physical properties of prepared AuO particle.

## *Year wise formulation of structure of the study:*

2024 – 25
The detailed survey of literature of the related field and study
Design of techniques for preparation of AuO nanoparticles.

2025 – 26
The AuO particle are prepared by using planned techniques The structural Morphological spectroscopic characterization will be carried out.

2026 – 27
The result and discussion planned work and preparation final draft of the work.

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Signature
Aniket Suryakant Shinde
Research Scholar

Signature
Dr. R. S. Shaikh
Research Supervisor
Dept. of Physics,
S.G.B.S. College, Purna (Jn.), Dist. Parbhani